Leburg Electronic Ignition System
EI10A
Installation Manual

For Aero VW's - Or Any 2 Or 4 Cylinder 4 Stroke Engine

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1. Read This First

By virtue of the techniques, design, components used and the care taken in building and testing, each ignition controller is believed to be highly reliable. The risk of failure is thus low, but it is finite. Therefore, this system is only made available on the basis that the user agrees to implement a Dual Ignition System.

The Leburg system is the dual system, with the power supply system described in this manual. If any change from this is intended, you will need to check with the LAA that they will accept it. If a different alternator or power system is used, again, you will need to check with the LAA that they will accept it.

The benefits of smooth running and getting the maximum power are obtained when the system is installed as described in this manual, with dual controllers, dual ignition spark plugs, both firing at the same time at the optimum advance angle.

When used in other arrangements e.g as a single unit with a magneto, the unit will provide a very effective back up, but the full benefits of having variable timing may not be realised since the magneto will fire at its fixed full advance timing and control the timing process. In this case the magneto should be considered the primary system and the Leburg system the back up.

1. Allocate the plug leads to the plugs by the method described.
2. Use only plug leads with high resistance (carbon) cores. Expect damage to the controllers if you use copper cored leads.
3. Set the gap between the magnet and sensors to about 4—6 mm.
4. Set plug gaps to 0.9 to 1.0 mm.
5. Do not use batteries smaller than 7Ah for the main or 2.8 Ah for the backup.
6. Always use Circuit Breakers rated as shown. Do not replace them with switches.
7. Do make sure that the wires are not bent, stressed, or free to vibrate, especially where they enter the Ignition Controllers.
8. The Ignition controllers will probably suffer permanent damage if the supply voltage to them is allowed to fall below 7V. If the ALARM light flashes in flight, indicating that there is something wrong with the power supply, believe it. Land, and don't fly again until you have found and resolved the problem. If the power system is installed correctly, you will have a comfortable safety margin.

9. Before flying for the first time, and at regular intervals after, make sure that you have checked that the alternator is working correctly. You need to check the voltage to each controller by increasing the RPM from idle. When the RPM reaches 1000 or similar, the voltage will suddenly increase by about 1 volt, from 12. 7 to about 13.5 - 14.4. This voltage should be maintained to 4,000 RPM.

10. Installing a digital voltmeter with a two way switch, to select A or B supply is a good investment, and you can do the alternator check with the magneto (ie Ignition Controller) check, i.e. each time before take off.

11. Make sure that the aircraft is left with ALL switches in the OFF position. If the batteries are inadvertently allowed to run down, remove them and recharge them with a suitable charger (not a lead acid type) before flying. Do not rely on the alternator to revive a dead battery.

12. The Yuasa batteries, while perfectly adequate when treated reasonably, are readily damaged if misused. After a rundown episode, do a capacity check. Do a capacity check once each year. If in doubt replace them with new units, they are cheap. If the batteries are high quality aircraft type, they may withstand misuse, and be usable for much longer.

2. The VW As An Aero Engine

Today there are specially designed 4 stroke aero engines available for the homebuilder. They are smaller, lighter, more powerful, have relatively modern ignition systems, and have alternators and starters. However, they cost many times more than an "as new" aero VW. A competent homebuilder can transform the VW Beetle engine into an "as new" reliable and economical aero engine, and have fun doing it.

It will produce about 63 BHP at 3,400 RPM in its 1834cc form and weigh about 65 kg (143lb), without a starter. It will be as fuel efficient as the new units, probably better than "proper" aero engines and much better than conventional 2-strokes. It has developed a reputation for good reliability. + The VW is still an attractive engine for homebuilders, except that ignition systems based on magnetos need regular attention to keep them working, and their mechanical drives have to be checked or replaced regularly. Also, the spark occurs at a fixed advance, usually at 27 degrees before TDC. Starting from cold or hot can be difficult. If the impulse unit fails, hand starting is potentially dangerous. The magnetos and drives are heavy and occupy the back of the engine, leaving little room for an alternator.

The attractiveness of the VW would be much improved if it could be coupled to a modern ignition system and a simple alternator.

The ignition system described in this manual has been specially designed to meet the requirements of the amateur aircraft builder and flyer.

The main aims are:

- To achieve exceptionally safe and easy starting when hand propping
- To get the best performance from the VW by firing the plugs at the optimum advance angle for all RPMs
- To be easy to install
- To be light, reliable, and economic

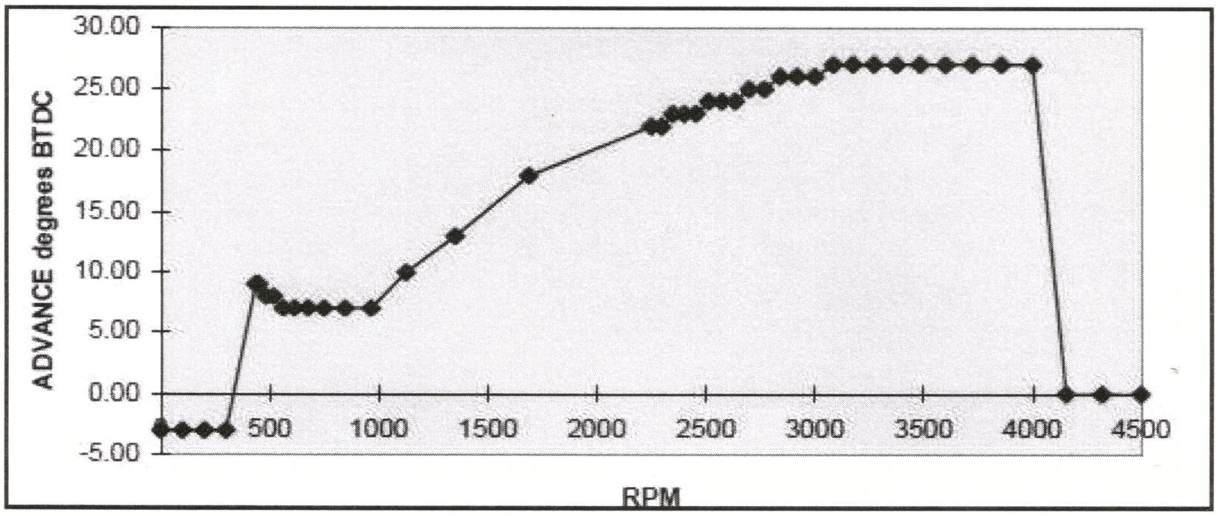
Experience on the ground and in the air shows that this system gives safe and easy starting by hand propping, smoother running at all speeds, it's compact and easy to fit but the real benefit is that once fitted it is maintenance free.

A backup power supply is added with a second small battery and two simple components, this will give about 7 hours power to the second ignition system should the main system fail.

In order to keep both the main and backup batteries fully charged automatically, it is necessary to fit an alternator. If you do not already have one this paper describes how to make and install a simple, cheap but high quality alternator. Having installed it, you have the additional benefit of having plenty of electrical power available for instruments, lights and even a starter.

3. Ignition System Performance

High Energy Spark
This system drives the coil to obtain the maximum spark energy that is compatible with avoiding excessive erosion of the plugs. For starting, and during the first few revolutions when running, this rule is ignored and roughly twice the running energy is produced to ensure a healthy spark. The spark plug gap is set to 0.8 to 1.0 mm, standard for auto applications, twice that normally used for magnetos.



Optimum Advance Timing
The diagram above shows how the advance varies with RPM. This curve results in clean, smooth running at all speeds and a steady, reliable idle.

Accurate Timing
As the system is driven direct from the crankshaft and as there are no mechanical drives or contact points, the timing point is free from small angular variations in timing (jitter). Thus the timing is accurate and remains free from drift with time.

Idle Trough
As is with most modern ignition systems, the timing advances when the RPM falls below 600 RPM. The result is a steady and reliable idle.

Easy Starting - Even With Hand Propping
When starting, the spark plug fires at 3 degrees AFTER TDC. This makes kick-back impossible. Additionally, the spark energy is boosted. When the first few revolutions have been completed the advance is mapped to the curve above. This results in a very positive but gentle start. The spark energy is produced regardless of the speed at which the prop is pulled through TDC. You need only to pull the prop through TDC cleanly, not quickly.

No Adjustments, No Moving Parts

It is a fit and forget system. There is nothing to wear. No adjustment is required or possible. It is tolerant of dirt. Maintenance consists of checking that the wiring connections and mountings are in good order. The battery capacity should be checked occasionally.

Low Power Requirement

As the Leburg is energy efficient, at 3000rpm each system only requires a maximum of 350 mA @ 12V.

Compact & Light

As can be seen from the pictures and drawings, the alternator extends less than 60 mm from the VW crankcase. One controller weighs 200g, and one coil weighs 630g (Visteon) or 960g (Zetec).

4. Principles Of Operation

The Leburg system is designed around the efficient coils that are used in modern automobiles. Ford coil packs are used as they are well tried, readily available and reasonably priced. Being vacuum impregnated with epoxy and having sealed EHT connector, they are very robust and water proof. Individual ignition leads are available from automotive accessory dealers.

Each ignition controller drives one coil pack and one coil pack drives 4 plugs. No distributor is required. Ford has two types of coil that are electrically similar and so suitable for the Leburg system. One unit (Zetec) is common in Europe, the other (Visteon) is more common in the US. The Visteon type is preferable since it is lighter (630g) than the Zetec (960g), but in the UK it is more expensive. Motorcycle racing coils with primary impedance of 3 ohms can also be use, these are usually dual output and can be used on 2 cylinder or 4 cylinder engines.

In order to be able to set the time for the next spark to occur, the ignition controller needs to know when the crankshaft passes the reference points. It gets this with the aid of a magnetic sensor and two magnets 180 degrees apart that are fixed to a rotor on the crankshaft. One has the N pole facing out, the other has the S-pole facing out. The N-pole corresponds to TDC for cylinders 1 and 3 (rear) and the S-pole corresponds to TDC for cylinders 2 and 4 (front).

When the engine is running, the crankshaft rotates and the magnetic sensor produces two reference pulses each revolution. These are fed to a microcontroller, which records the time of each reference to microsecond accuracy on an internal clock. From these times the RPM is calculated and the required timing advance angle is derived. The actual time of the next spark is calculated, and when the clock reaches this value, the appropriate pair of plugs fire. Which pair is fired depends on whether the last reference pulse was from a N-pole or a S-pole.

For starting, the priority is to prevent kickback and ensure a big spark. To achieve this the spark occurs at 3 degrees AFTER TDC. The active edge of each magnet is physically installed at this point and this generates the spark immediately.

A spark occurs every time a piston approaches TDC. Thus one spark is “wasted” as it occurs at the end of the exhaust phase, and so has no effect. The benefit of this is that no distributor is required and the accuracy of the spark timing is improved, as the timing is taken directly from the crank, not through the gear driven camshaft.

The microcontroller does a number of other things as well as controlling the main timing process. It adjusts the timing subtly to improve the engine power output and fuel consumption. It ensures that electrical energy taken from the power supply system is used in the most efficient manner. A TACHO output is also provided to drive an electronic tacho (+12V) at two pulses per revolution. It has a built in voltmeter which measures and monitors the input voltage, and produces an ALARM output which can drive a LED (light emitting diode) and/or a sounder up to a maximum of 75ma. Three distinct patterns are produced:-

1. CLEAR PROP—the ignition is live , although not running—indicator alternates at 1 second intervals.
2. LOW VOLTS—the input voltage is below 11.5v—indicator alternates at 2 second intervals.
3. HIGH VOLTS—the input voltage is above 15.5v—indicator alternates at 0.5 second intervals.

KEEP IT COOL!

The main enemy of reliability of electrical and electronic systems is heat. To avoid problems keep the temperature of the controller, the coils and the alternator stator below 50 C when the engine is running ie when air is being blown through the engine compartment. This may mean that special provision has to be made to direct fresh air at them. Compared to the cooling requirements of the engine, only a tiny amount is required.

5. Set Up

The EXTERNAL timing sensor is fixed in the tip of an AL tube and can be mounted anywhere convenient on the engine that fixes it near the rotor. The external sensor is embedded in the end of an AL tube ½ dia X 1 ½ long. This is connected to the controller with a shielded lead which has a connector at its other end. This plugs into a connector on the ignition controller. The sensors can then be mounted in simple AL clamps that can be made from 1 ¼ X ¼ AL bar and fixed to the M6 holes tapped into the front of the crankcase. The ignition controllers and the coils can be fixed anywhere convenient in the engine compartment.

Alternatively you can use the Leburg TIMING DISC (EI10ATDISC01) as the rotor.

Drawing—Timing Disc Details VW can be found in section 11 Drawings.

This is a 1/16 thick alloy disc which is sandwiched between the prop and the drive hub. The magnets are then epoxied securely in to the rim of the disc, on for either 100mm pcd or 4.00" pcd. This disc is fitted without modification between the prop and the prop driving hub if the drive spigots are ½" dia and mounted on a PCD of either 100mm or 4.00". The excellent ACRO prop hub has the holes at 100 PCD. The external sensor has then to be mounted so that its tip is 4 - 6mm from each magnet as it passes, should you have problems on testing that all plugs fire at TDC and BDC then increase the gap between the magnets and sensor.

Ignition Controller (EI0AEXT01)

This is a small box which houses the microprocessor and its electronics. It has three connectors. One has the power and optional service outputs (TACHO, ALARM). The second connects to the coil unit. The third connects to the external sensor. A dual system uses two such controllers.

Coil Pack

The unit used is the 4 outlet type used on many current Ford vehicles. There are two suitable types. One is the Visteon (US Ford) which is used on the Focus, and the other (the "Zetec") is used on most others. The Visteon weighs 630g, the Zetec weighs 960g. Clearly the Visteon is preferable, but it is currently about 50% more expensive. A dual system uses two coils.

Timing Disc (EI10ATDISC01)

This suits a drive hub which has ½" drive spigots arranged on a PCD of 100mm or 4.00". It is fixed by clamping between the propeller and the drive hub. The magnets are epoxied in the rim of the disc with opposing poles facing outwards. One disc serves a single or a dual system.

Magnetic Sensor

The external sensor is mounted within a 12.7 dia X 38 long (½" dia X 1 "long) AL tube. It can be fixed to the front of the VW crankcase with a suitable mount on the existing M6 tapped hole. A dual system uses two sensors.

Some of the components on this page and the previous page are shown in drawing 107-80-010 which can be found in section 11 Drawings.

Parts List for dual ignition, included within a Dual Ignition Kit P/N LEBURGDKIT.

Description	P/N	Quantity	Source
Coil	LEBURGCOIL	2	Skycraft
Coil Loom	LEBURGCOILL	2	Skycraft
Sensor	LEBURGSEND	2	Skycraft
EI Module	LEBURGEIMODULE	2	Skycraft
Timing Disc	LEBDISK	1	Skycraft
JB Weld	JBWELD	1	Skycraft
Power Loom	LEBURGMAINL	2	Skycraft
Sensor Bracket A	MOUNTA	1	Skycraft
Sensor Bracket B	MOUNTB	1	Skycraft
Magnets	LEBURGMAG	2	Skycraft

6. Power Supply

Dual ignition units require independent supplies such that a failure on one, whether low voltage or a short circuit, will not adversely affect the other.

This will at least require that you have a separate battery for each system. You will have to ensure that each battery is charged and in good condition before each flight. This approach is clearly requires a high level of attention, so from a safety view this is not desirable.

It is safer, and much more practical to have a maintenance free system. For this an engine powered alternator and a battery is required. This main power system (A POWER) then powers one ignition system (A IGNITION). The second system can then made a backup supply (B POWER) by connecting the main system to a small backup battery of say 2 Ah through a diode and a 0.5A circuit breaker. Should the main system fail the B POWER system will give a minimum of 7 hours running to the B IGNITION.

In normal use, both ignition systems are fed by the alternator, so to this extent the system is self generating.

Many users will have a system consisting of alternator and main battery already. For those that do not have an alternator, a very effective but cheap alternator is described in the following alternator section.

The alternator section is for information purposes only. Skycraft is not responsible for any non-Skycraft supplied parts.

Similar components are available new and they can be used. However the Honda parts are of excellent quality and cheap when obtained from motor cycle breakers (salvage).

The power system drawing can be found in section 11 Drawings.

7. Fitting A Honda Alternator

IMPORTANT: The information that refers to the alternator forms no part of the ignition system. It is offered as a suggestion to help users install an alternator. The numbers are for guidance and not to be considered accurate.

Note: The alternators of many of the "superbikes" are physically similar, so it is feasible to use an alternator from another source. However, you will then have to work out the detail dimensions of each components. For the sake of simplicity this booklet confines itself to the components from a Honda CBR600F.

The weight of the rotor, stator and regulator amount to about 2.2kg (4.8lb). While this may seem heavy you will be hard pressed to improve on this. You can buy "lightweight alternators" for racing cars which weigh about 6lb with a pulley drive and mount. They are fairly expensive. (~£150). The CBR600 parts can be had for about £100 from motorcycle breakers and are of good quality.

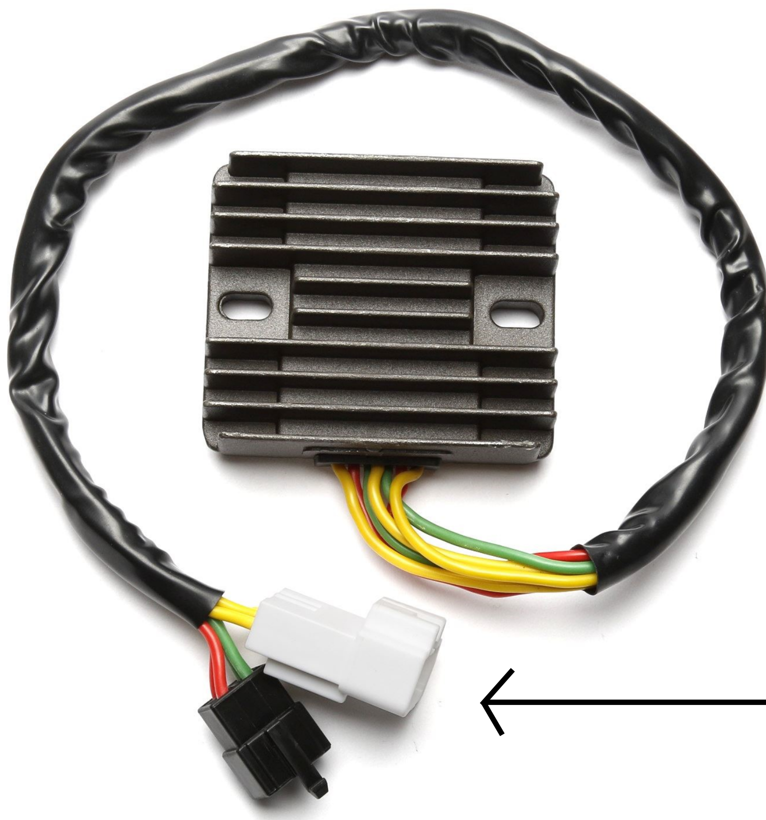
For those that are starting from scratch, then, an alternator from a motor bike, usually one of the superbikes, makes a very good alternator. It has no bearings or brushes or any rubbing parts. The 3phase output from the alternator is very effectively rectified and regulated by a solid state unit to give a constant 13.5 V dc which when connected to a lead acid battery, will keep it fully charged.

1. The rotor.
This is in the form of a shallow steel saucepan, about 41 high and 126 diameter with a thick (about 10) rim. The rim contains the magnets which produce a very strong magnetic field inside the rotor.

2. The stator.
This is an array of some 18 coils placed around the rim of a laminated iron core which fits inside the rotor. The power is taken from the stator on three wires.

3. The rectifier/regulator. This is a small electronic module that takes in the 3 phase output from the stator windings and transforms it to a steady 13.5V dc regardless of speed and load, within reasonable conditions. When connected directly to a lead acid battery, this voltage will bring it to full charge and maintain it there.

4. The connector that mates with that on the rectifier/regulator. It is usual to get the whole cable form. When you arrive home, cut off the connector you need, with as much cable attached as possible.



Ensure that all 4 parts come from the same machine to ensure compatibility.

You have to make up various mechanical parts to mount the alternator to the engine. These are best understood by looking at the drawings.

The thrust bearing described later bolts onto the end of the crankshaft with the usual M28 bolt. The rotor is then bolted to the thrust bearing with 6 off SKT CAP M5 X 12 screws.

Parts List For Alternator

	Description	P/N	Source	Quantity
1	Rotor	31110-MV9-671	Ex CBR600 F2/F3	1
2	Stator	31110-MV9-671	Ex CBR600 F2/F3	1
3	Rectifier/Regulator	31600-MV4-000	Ex CBR600 F2/F3	1
4	Rectifier/Regulator Connector		Ex CBR600 F2/F3	1
5	Thrust Bearing	107-80-009	Make From Drawing	1
6	Spacer 2	107-80-018	Make From Drawing	1
7	Engine Plate	107-80-017	Make From Drawing	1
8	Pillar 1B	107-80-019	Make From Drawing	4
9	Pillar 2B	107-80-020	Make From Drawing	4
10	Stator Plate	107-80-016	Make From Drawing	1
11	Spring Tension (roll) Pin 3.0		Fastener Supplier	2
12	SHCS M5 x 10	M5X10SHCS	Skycraft	2
13	SHCS M5 x 12	M5X12SHCS	Skycraft	6
14	SHCS M6 x 20	M6X20SHCS	Skycraft	4
15	SHCS M6 x 40	M6X40SHCS	Skycraft	4
16	SHCS M6 x 60	M6X60SHCS	Skycraft	4
17	M6 Self Locking Nut	NUT-M6	Skycraft	8
18	M6 Plain Washer	AN960-416	Skycraft	8
19	CB Switch 10A Alternator	597-909	Farnell	1
20	CB Switch 8A Services	597-892	Farnell	1
21	CB Switch 1A Backup	597-897	Farnell	1
22	DPDT Toggle AIGN	285-936	Farnell	1
23	SPST Toggle BIGN	285-900	Farnell	1

8. Manufacture & Assembly Notes

Getting The Parts Made

Many homebuilders will decide that they have the skills to make the parts themselves. This is fine. The prototype parts were made in the garage workshop and they cost very little. The fitting was a bit awkward since holes had to be "pulled" with a file, but the result is perfectly sound.

You could take the drawings to a competent engineering firm and have them made. This should result in parts made to a very high accuracy (ie within 0.0005 in) which will make assembly easy. These will cost a bit more, but it is worth getting some quotes.

The thrust bearing needs to be accurate, so this is certainly worth having made professionally.

Reworking The CBR600F Rotor

The rotor is usually supplied with odd bits of the starter mechanism bolted or riveted to it. These need to be removed, and you will need to drill 6 off 5.2 diameter holes in the back of the rotor to fix it to the thrust bearing (you can see the cap screws M5 X 12 that fit these holes in Fig 11 and 12).

Either operation will produce swarf, which unless you take preventative measures BEFORE DRILLING, will stick to the inside of the rotor, and be difficult to remove, so note the following paragraph before proceeding with the rework.

One method for coping with swarf in a strongly magnetic environment is to clean and degrease the inside of the rotor thoroughly BEFORE machining. Lay up 3 layers of duct tape against the inside of the rim, ensuring that the inside corner is covered. The thickness of the tape reduces the force of attraction between the swarf and the magnets. After machining, swarf can then be removed first by cleaning in the normal way, ie any way that works, and then pressing down a fourth layer of duct tape over the swarf. Complete by removing all the duct tape, with the swarf enclosed.

Thrust Bearing

The thrust bearing is probably the most difficult part to make. The turning is easy, but drilling the holes accurately is tricky. The prototype was made by the author, so it can be done but you can probably find a local precision engineer with a mill with a Digital Read Out (DRO) device who will make it to a very high accuracy for a reasonable price. Drilling the 6 X M5 tapped holes accurately needs much care. Before making the thrust bearing check a) that the 53.5 dimension suits the end of your particular crankshaft, and b) that the 49.9 dimension fits the internal diameter of your motor cycle rotor. The thrust bearing replaces the flywheel on a road VW. It engages on the 4 X 8.0 dia drive pins and bolts onto the end of the crankshaft. It provides a) the shoulder that transmits the propeller thrust to the thrust surface on the rear main shells, b) the seal surface for the oil seal and c) a convenient array of tapped holes to which the motor cycle alternator rotor or a V-pulley can be fixed. Unlike the flywheel on a road vehicle, the thrust bearing is required to transmit only about 200 W of power (1/4BHP), and that to a smooth and vibration free load. The normal flywheel fixing of an M28 bolt is used. About 100 Nm of torque should be OK. It is advisable to use Loctite and a locking washer with tabs on final assembly. The thrust bearing and oil seal surfaces must be free from blemishes, and concentric with the crank. In the prototype these surfaces were finished by lapping with 400 grade wet and dry backed with a smooth flat surface.

Engine Plate

This is drawn as made from 1/8 thick AL sheet.. Then the "c " holes are M5 HANK bushes (threaded bushes). The plate could be made from ¼ material, when the "c" holes could be tapped M5.

Mark out the vertical and horizontal centre lines and when you are satisfied that they are accurate, drill the "a" holes as vertical and horizontal reference marks. The two horizontal holes are used to fix alignment pins into the crankcase when the rotor and stator are assembled and checked for concentricity. Ensure that there is a clear horizontal line scribed between the horizontal "a" holes. This will be needed when the magnets are positioned on the rotor.

Stator Plate

This plate supports the stator winding on short pillars (PILLAR 2). The stator mount plate, made from 3.2 mm (10G) AL, is itself mounted to the ENGINE PLATE on somewhat longer pillars (PILLAR 1). Aim for concentricity when marking out the fixing holes. The various large holes in this plate are required to a) allow cooling air to pass through the stator windings, b) to allow access to measure the clearance between the rotor and the stator, and c) to allow the three output wires to pass through. Do not omit them.

Spacer 2

The 4 off SPACER 2's space the engine plate 5 mm from the crankcase face to clear the gearbox alignment land. When you are satisfied that the whole assembly is concentric, degrease the gearbox face and epoxy the SPACER 2's onto the gearbox to aid assembly.

Pillars 1 & 2

These are very straightforward to make. Each pillar is threaded M6 internally so that the pillars can be fixed either to the engine plate with the M6 X 60 screws in the case of PILLAR 1, or to the stator with M6 X 40 screws in the case of PILLAR 2. In both cases this aids assembly. When you are satisfied with the fit, put Loctite on the threads, so that you will not need to get access to the heads of the M6 screws to tighten the nuts when assembling.

Engine Plate Assembly
Note 1:

The instructions here refer to the work required to fit the ignition and alternator parts. Where engine assembly proper is required. you should refer to one of the standard assembly books eg Haynes VW or HAPI Manual.

Note 2:

As some fiddling is inevitable, all the initial trial assembly ie Steps 1 thru 8, is done without Loctite etc and with plain nuts, which are drawn up with just enough torque to hold the parts together firmly. When the assembly is complete, replace the plain nuts with antivibration nuts.

Assemble all the parts.

Once the stator is offered to the rotor the magnetic field will “suck” it into the rotor and hold it firmly to one side of the rotor. Clearly the assembly task is to fix the engine plate to the crankcase so that the rotor and stator are concentric, ie the gap between them is even and about 1 mm all the way round the stator.

To do this you will need to make up 4 some AL feeler gauges, about 50 X 6 from 0.9 mm AL. These can then be placed between the rotor and stator through the holes on the stator plate and the engine plate is positioned squarely to the crankcase and clamped to it with C clamps.

The alignment should be helped by using the “a” holes which lie on the vertical and horizontal axes.

When the clearance is even and the engine plate is square, the clamps should be made firm. Then using the horizontal “a” holes as a guide, drill through them into the crankcase flange with a 3.0 dia drill.

Check that the clearance around the rotor is still right. If so, remove the assembly and drive in two 3.0 mm spring tension pins (roll pins) into the gearbox holes, leaving about 4 mm sticking out as guide pins. These serve to guide the alternator assembly onto the crankcase. Then enlarge the “a” holes in the ENGINE PLATE to 3.2 mm to give a clearance fit on the 3 mm roll pin. The whole alternator assembly can then be removed and replaced accurately as required.

Replace the alternator assembly on the guide pins now in place. Clamp it to the crankcase. Recheck the clearance. If still OK drill and tap M6 into the crankcase using the 4 external “b” holes as guides. The tapping drill for M6 is 5.0 mm. The alternator assembly can now be fixed tightly to the crankcase using the M6 X 20 SKT CAP HEAD bolts, each with a SPACER 2 between the ENGINE PLATE and the crankcase. This spacer can be epoxied to the crankcase, after cleaning and abrading the glue area.

Alternatively, you could drill right through the crankcase and use a M6 bolt, but the rear of the flange is not flat. You would have to devise a wedge to make a flat seat for the nut.

Set Up The Axial Crankshaft Play

Refer to your VW reference manual for this. Between 0.10 to 0.15 (0.004 to 0.006”) is about right.

Make sure that you have sealed the end of the crankshaft against the inside face of the thrust bearing. Use the paper oil seal gasket and a proper gasket sealing compound also. Leaks from here can be annoying and messy.

Torque the M28 screw and lock it with Loctite and a tab washer. Bolt the rotor to the THRUST BEARING with 6 off M5 X 10 SKT CAP HEAD bolts.

Check The Clearance Between The Rotor & The Stator

Drawing 107-80-005 shows where there could be interference between the rotor and the stator fixing bolts (M6 X 40) . Check this. If there is a problem the solution may be had by reducing the head thickness of the M6 X 40 bolts, or adjusting the length of the spacers.

Fixing The Timing Magnets To The Alternator Rotor

Assemble the alternator assembly to the crankcase, but remove the stator plate assembly.

Having assembled the alternator, the aim here is to mark out and fix the timing magnets so that the leading edge of each magnet is 12 mm above the face of the engine plate and at 3 degrees after TDC.

When the controller is bolted to the ENGINE PLATE, the sensor is on the horizontal axis but at a height of 12 mm from the base. Thus you need to position a scriber 12 mm above the surface of the engine plate with the tip in contact with the rotor and rotate the rotor 360 degrees. This will leave a line at the correct height around the rotor periphery.

Set the crankshaft to TDC for cylinders 1 and 3. Scribe a line perpendicular to the line scribed above so that when extended it touches the horizontal reference line. Rotate the crank to TDC for cylinders 2 and 4, (ie through 180 degrees), and repeat the procedure.

Having established where the TDC points are it is straightforward to mark the TDC+3 points.

The first task is to calculate what distance along the circumference of the rotor corresponds to 3 degrees. Knowing the diameter of the rotor, calculate its circumference. This will be about 400 mm. This corresponds with 360 degrees, so by dividing the circumference by 120, we obtain the distance round the rotor that corresponds to 3 degrees. It will be about 3.3 mm.

Draw a line this distance (~3.3mm) from the TDC marks so that it is AFTER TDC for cylinders 1 and 3. The tricky bit here is to mark it AFTER and not BEFORE. If in doubt go to the front of the engine and rotate the propeller in the direction it runs, until you get to TDC. Then move it a further 3 degrees. Go back to your rotor to see where to make your mark.

It is easy to get this wrong. Keep checking this until you are satisfied that you have got it right. Then mark the rotor. When this is done, repeat the process to mark the TDC + 3 point for cylinders 2 and 4.

Separate the magnets, mark the N pole on one and the S pole on the other. Clean them thoroughly.

NOTE. The magnets are very brittle and will chip if allowed to drop onto the rotor or any piece of steel. The magnets are very strong and have to be restrained forcibly to prevent this.

Clean the rotor circumference thoroughly. With a drop of epoxy, stick one magnet with its N pole facing out to the rotor so that its centre is on the 12 mm line and its advancing edge is on the TDC+3 line for cylinders 1 and 3. Repeat to fix the S-pole on the TDC+3 mark for cylinders 2 and 4.

When the epoxy is dry, check with a compass that one magnet has the N pole outwards, and that the other has the S pole outwards, and check that the advancing edge on each magnet is positioned correctly. If there is a problem, the epoxy can be softened with a hot air gun and the magnet can be removed.

When you are satisfied that the magnets are positioned correctly, and the epoxy is dry, the strip of brass can be laid over the magnets. It s ends should overlap about 20 mm. Mark where the overlap occurs.

Remove the brass and silver solder the ends to make a band. Clean it and try it again over the magnets, ensuring that the join is midway between the magnets and the lap direction is correct (see 107-80005). If the band is a little tight, it can be stretched by pushing a screwdriver blade under the band where the magnets sit. If it is a little loose, remove the band and put in it a series of evenly spaced wavy bends. If neither fix works, you will have to remake the silver soldered joint. When the fit over the magnets is close and reasonably low elsewhere, clean up the band and the rotor. Replace the band and inject epoxy under the band, to fix the band and prevent dirt getting in under the band. The result may not look neat but it should be sound.

More On The Brass Band

This is made from a strip of brass about 420 X 10 X 0.25. This is wrapped snugly but not too tightly around the rotor over the magnets and marked at the overlap for the join. The lap area then needs to be silver soldered (hard soldered). Soft solder fatigues very quickly in the presence of vibration and it will NOT be safe. Ensure that the lap is directed so that if it does rub against anything the lap will be pushed down and not picked up.

When joined, the ring can then be made slightly wavy so that when put over the rotor it will be both able to extend in circumference and yet hold firmly to the magnets. Eventually it will be held in place with epoxy to keep it in place and prevent dirt building up under it.

Finally, when the system is checked out, replace the plain nuts with antivibration nuts.

9. Wiring Notes

Electrical Noise

The wiring as defined in the diagram is intended to minimise the effects of noise. If you fail to follow the wiring diagram or simplify it, the system may still apparently work OK, but you may have increased the noise level, and reduced your margin of safety.

Run Power Wires Together

The ignition controllers (as well as all devices) require 2 wires to receive their power. One is the +12V supply, usually red , the other is the 0V wire usually black. These will originate near the battery. Run each pair side by side, even slightly twisted together. This applies to the wires to the ignition controllers, to the electrical pump, if you have one, and the alternator wires.

Earth Bonding

Ensure that all the major metallic items ie crankcase, engine plate components, engine mount, instrument panel, battery box, etc are bonded together electrically. Because of paint, dirt, corrosion, rubber bushes etc, this may require that you have to add conducting links between say the engine and the mount. It is good practice to bond ALL metallic parts together.

Keep To The Wiring Diagram

The wiring diagram 107-80-010 shows a number of wires particularly in the 0V circuit that appear to be redundant. These are deliberate and are intended to a) offer a certain amount of redundancy and hence safety should one wire break, b) make a low impedance (not just low resistance) connection between the battery and the controllers, c) reduce the EMI energy radiated by the system, and keep background noise under control. Do not simplify it.

Wire Sizes

Also, the wire used may appear heavier than you might expect. Although the average current taken by the ignition controllers is low, they take the current in short sharp pulses. Don’t use thinner wire.

Wires labelled 16/02 refer to wire with 16 strands each with a diameter of 0.2 mm, making a total cross section area of 0.5 mm 2. This is comparable to AWG 20.

Coil Leads

The RED wire from controller coil connector has a filtered +12V supply on it when the unit is live. If this lead becomes removed from the connector and allowed to touch ground (0V) the controller will be damaged, so avoid this at all costs.

Push On Terminals

PUSH ON terminals are often found on switches and components. These are in general use and as long as they are not removed and replaced often they are acceptable. They should be checked for tightness. Any looseness should be rectified by squeezing them carefully or replacing them.

Crimping

Use crimped connections in the wiring as far as possible. Soldered terminations are prone to fatigue unless supported very carefully.

Use the correct crimp tool. Make some experimental crimps before starting on the aircraft wiring. If you can pull the wire out of the crimp, then something is wrong. Check that your crimp is gripping both the bare wire and the insulation. You may need a magnifier to see clearly what is going on.

Stripping

When stripping insulation from a wire, take care that you do not cut any strands. If you do cut a strand you have one problem in that you are reducing the current capability of the connection. You also have a potential second problem in that the lost strand may end up where it can cause a lot of havoc.

Likewise, when inserting a stripped end of wire into a crimp terminal, for example, ensure that ALL the strands go into the terminal. A head mounted binocular magnifier is a great help in checking such details.

Terminal Blocks

If you use terminal blocks, it is preferable to use those with screw terminals which take a crimped eye or fork terminal. If you use the type with a screw that presses down onto the wire use only the type that has metal leaf to protect the wire strands. The common household type seldom has this leaf and should not be used.

Support Wires

Wires should be well supported and not left to flex under their own weight in a vibrating environment. This is particularly important where you have made a join, since at the join you have also induced stress concentrations in the strands and have work hardened them. Aim to support a wire within 50 mm of a joint and thereafter at least every 100 mm.

Do not install wires so that they are in tension or compression, particularly near a joint. Aim to have the wire slightly looped near a joint so that a pull will not stress the joint.

Access

Remember that you may well have need to take out a component once you have installed it. Install the components of the system in such a way that you can get to them or remove them easily.

Ignition Switches

We suggest that for the ignition switches you use a good quality toggle switches. Choose units with a firm snap action of about 10A rating. These should be large and strong to withstand.

Leburg Ignition Modules WARNING

The Leburg Ignition Modules must not be energised without a coil pack and 4 grounded spark plugs connected.

You must make sure the Leburg module and spark plugs are correctly grounded before use.

Failure of completion for either of the above, could result in a breakdown of the module.

10. Wiring The Spark Plugs

When you have put the system together and it's ready to run, you then have to decide which plug lead goes to which plug. It may look confusing, but the easiest and safest way to decide this is described here. However, first of all REMOVE ALL PLUGS FROM ALL CYLINDER HEADS.

If you fail to do this, the risk is that when rotating the propeller through TDC the engine may fire and do you damage.

1. Deal with one system at a time. Start with the A system then go to the B system.

2. Put all the spark plugs into A plug connectors and lay the plugs on the top of the engine so that you can see and hear the sparks.

3. Turn on the A power, and rotate the crankshaft with the propeller through TDC (actually 3 degrees after TDC).

4. You should see that 2 of the 4 plugs fire when you do this. Put a thin screwdriver into the plug holes. You will find that either the front pair or the rear pair of cylinders will be at TDC. Mark the pair of plugs leads that fire, F or R (Front or Rear) to match the cylinders that are at TDC.

5. Note: 1) either plug can go into either cylinder. 2) you can move the prop slowly backwards then forwards to do this test, but don't do it faster that one spark per second or the ignition will think that the engine is running and will go into a different mode of operation.

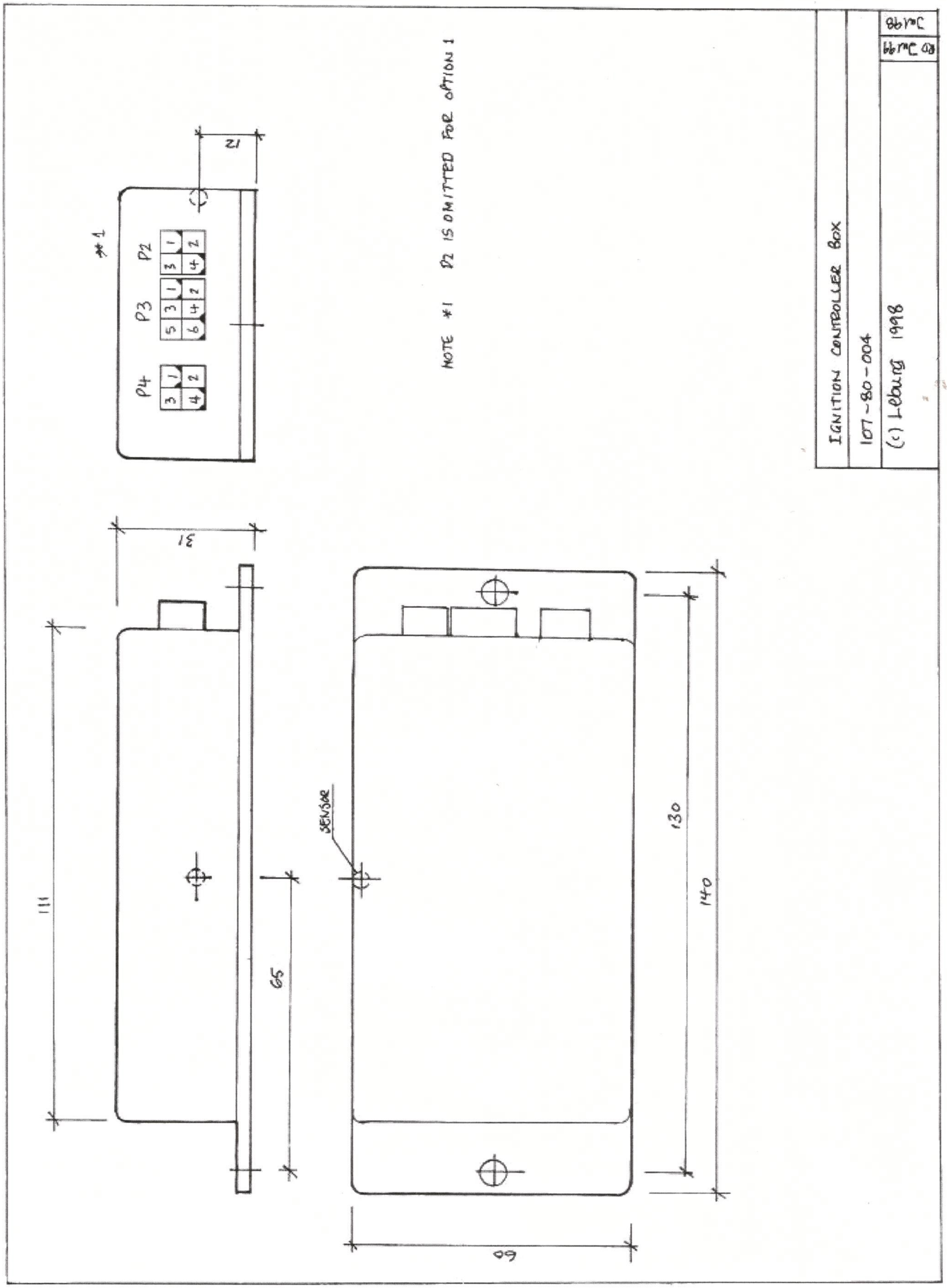
6. It follows that for 4 cylinder engine the other pair of plugs go into the remaining pair of cylinders. Confirm this by rotating the propeller through 180 degrees and check that the other pair of plugs fire when the other pair of cylinders a re at TDC. Mark the plug lead pair to suit.

7. Rearrange the plug leads on the coil to suit the length of the leads. The A system is now set up. Turn off the A system and repeat 2 to 6 reading B for A.

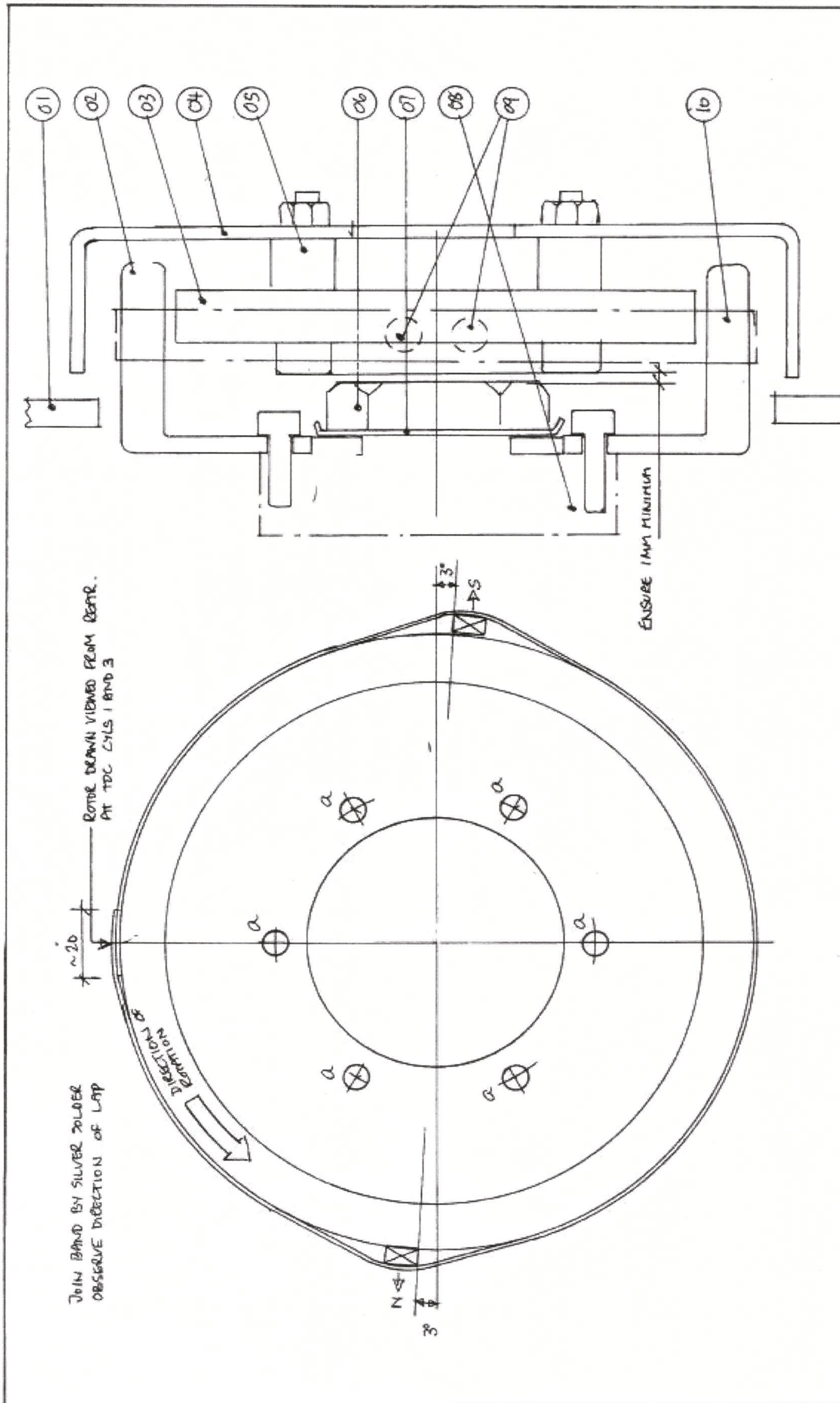
8. Replace the plugs in the cylinders and connect up the plug leads to the appropriate cylinders. From now on, expect the engine to start when the power is ON to A or B, and you move the prop through TDC.

11. Drawings

Drawing Number	Description
107-80-004	Ignition Controller Box
107-80-005	Rotor Details
107-80-006	Ignition Controller Block
107-80-009	Thrust Bearing
107-80-010	Electronic Ignition Option 2
107-80-011	Electronic Ignition
107-80-016	Stator Plate
107-80-017	Engine Plate C
107-80-018	Spacer 2B
107-80-019	Pillar 1B
107-80-020	Pillar 2B
	Timing Disc Details (VW)
	VW Sensor Mounts, Typical
	Power System



IGNITION CONTROLLER BOX
107-80-004
(c) Leburg 1998
NOTE *1 P2 IS OMITTED FOR OPTION 1
*1
P4
P3
P2
SENSOR
111
31
21
65
130
140
60



REF	ITEM		QTY	REF	ITEM		QTY
01	ENGINE PLATE	107-80-001	1	06	M28 BOLT	Ex VW	1
02	ROTOR	Ex CBR600	1	07	M28 WASHER	Ex VW	1
03	STATOR	Ex CBR 600	1	08	THRUST BEARING	107-80-009	1
04	STATOR PLATE	107-80-002	1	09	MAGNETS	7Ø x 3t Leburg	2
05	PILLAR 2	107-80-008	4	10	BRASS BAND	420 x 10 x 0.25 BRASS	1

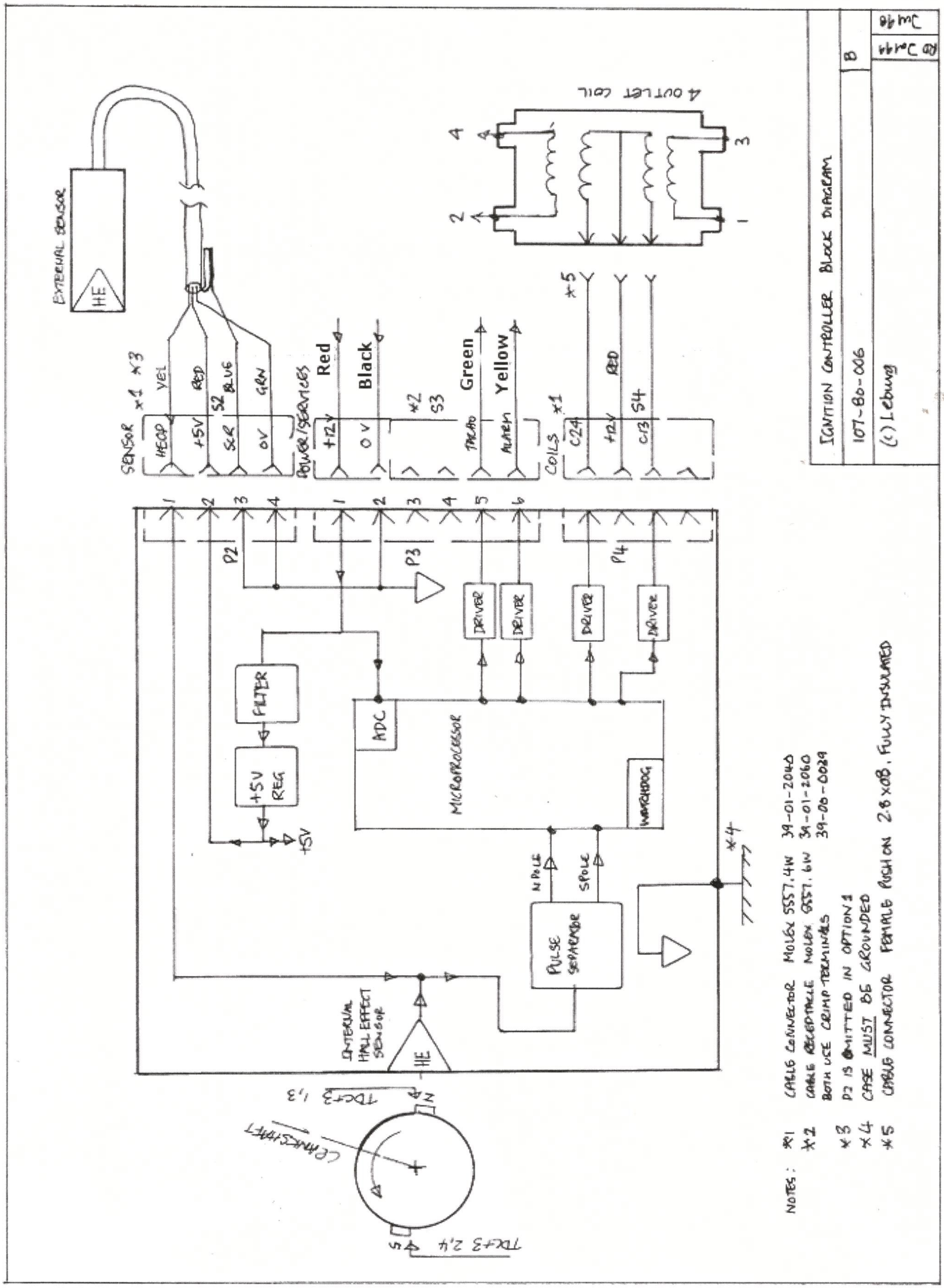
ROTOR DETAILS

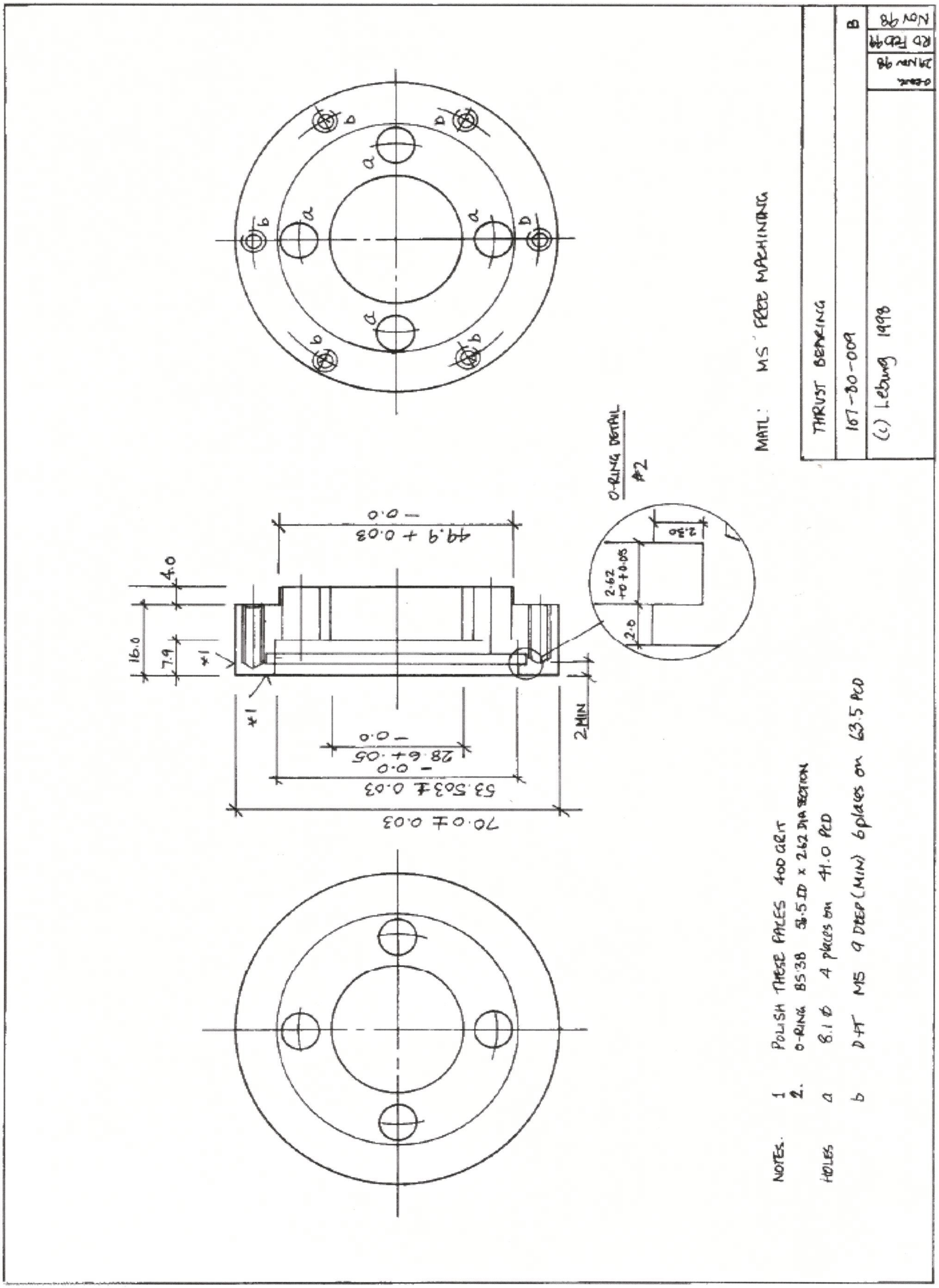
107-80-005

(c) Leburg 1998

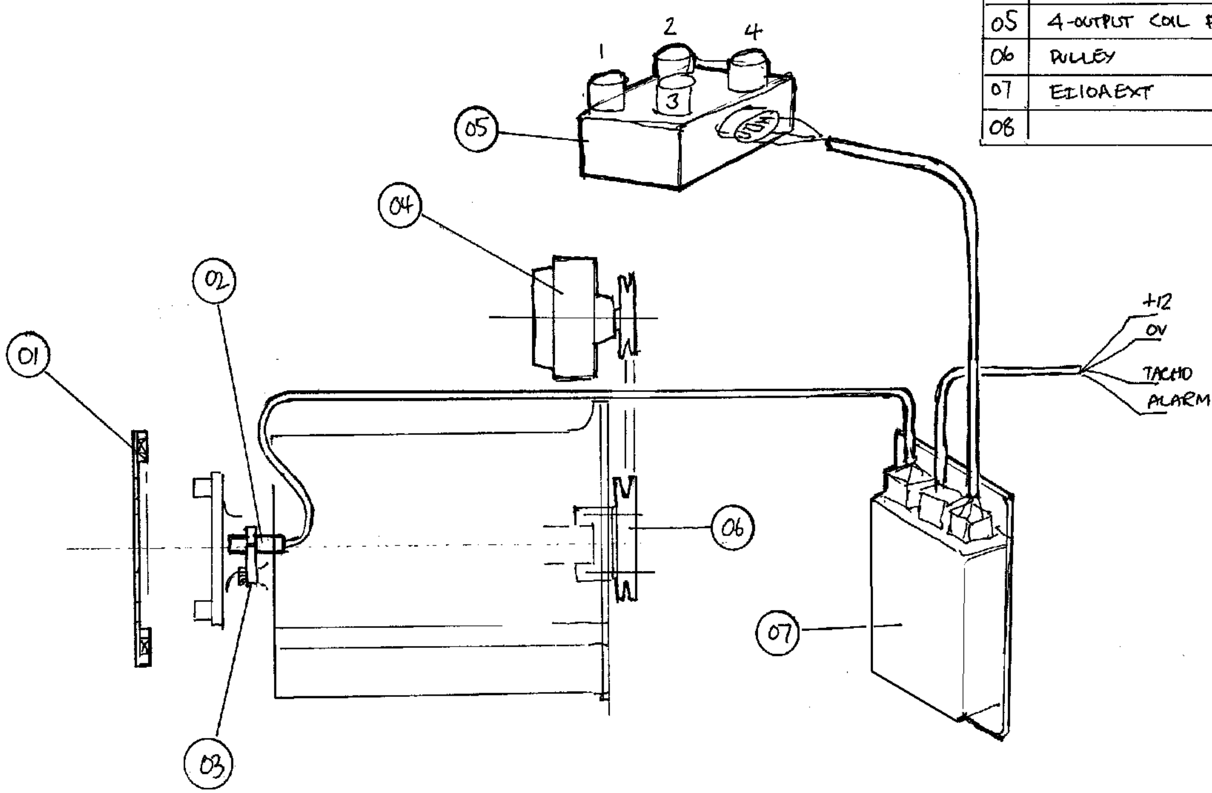
RD Jul 99

JW 98


EXTERNAL SENSOR
HE
SENSOR *1 *3
HECOP
+5V
SCR
0V
YEL
RED
S2 BLUE
GRN
POWER/SERVICES
+12V
0V
Red
Black
*2
S3
TACHO
ALARM
Green
Yellow
COILS *1
C24
+12V
C13
S4
RED
*5
4 OUTLET COIL
P2
P3
P4
DRIVER
FILTER
+5V REG
ADC
MICROPROCESSOR
WATCHDOG
N POLE
S POLE
PULSE SEPARATOR
INTERNAL HALL EFFECT SENSOR
CRANKSHAFT
TDC+3 1,3
TDC+3 2,4
IGNITION CONTROLLER BLOCK DIAGRAM
107-B0-006
(c) Leburg
NOTES:
*1 CABLE CONNECTOR MOLEX 5557.4W 39-01-2040
*2 CABLE RECEPTACLE MOLEX 5557.6W 39-01-2060
BOTH USE CRIMP TERMINALS 39-00-0039
*3 P2 IS OMITTED IN OPTION 1
*4 CASE MUST BE GROUNDED
*5 CABLE CONNECTOR FEMALE PUSH ON 2.8 x 0.8, FULLY INSULATED


MATL: MS FREE MACHINING
THRUST BEARING
167-30-009
(c) Leburg 1998
O-RING DETAIL #2
2.62 +0 +0.05
2.0
2.30
49.9 + 0.03 − 0.0
28.6 +.05 − 0.0
53.503 ∓ 0.03
70.0 ∓ 0.03
16.0
7.9
4.0
2 MIN
NOTES. 1 POLISH THESE FACES 400 GRIT
2. O-RING BS 38 56.5 ID x 2.62 DIA SECTION
HOLES a 8.1 ⌀ 4 places on 41.0 PCD
b D+T M5 9 DEEP (MIN) 6 places on 63.5 PCD

REF	ITEM		
01	GF DISC WITH MAGNETS	Leburg	optional
02	EXTERNAL SENSOR	Leburg	essential
03	FRONT SENSOR MOUNT		optional
04	CAR TYPE ALTERNATOR		optional
05	4-OUTPUT COIL FORD		essential
06	PULLEY		optional
07	EI10A EXT	Leburg	essential
08			

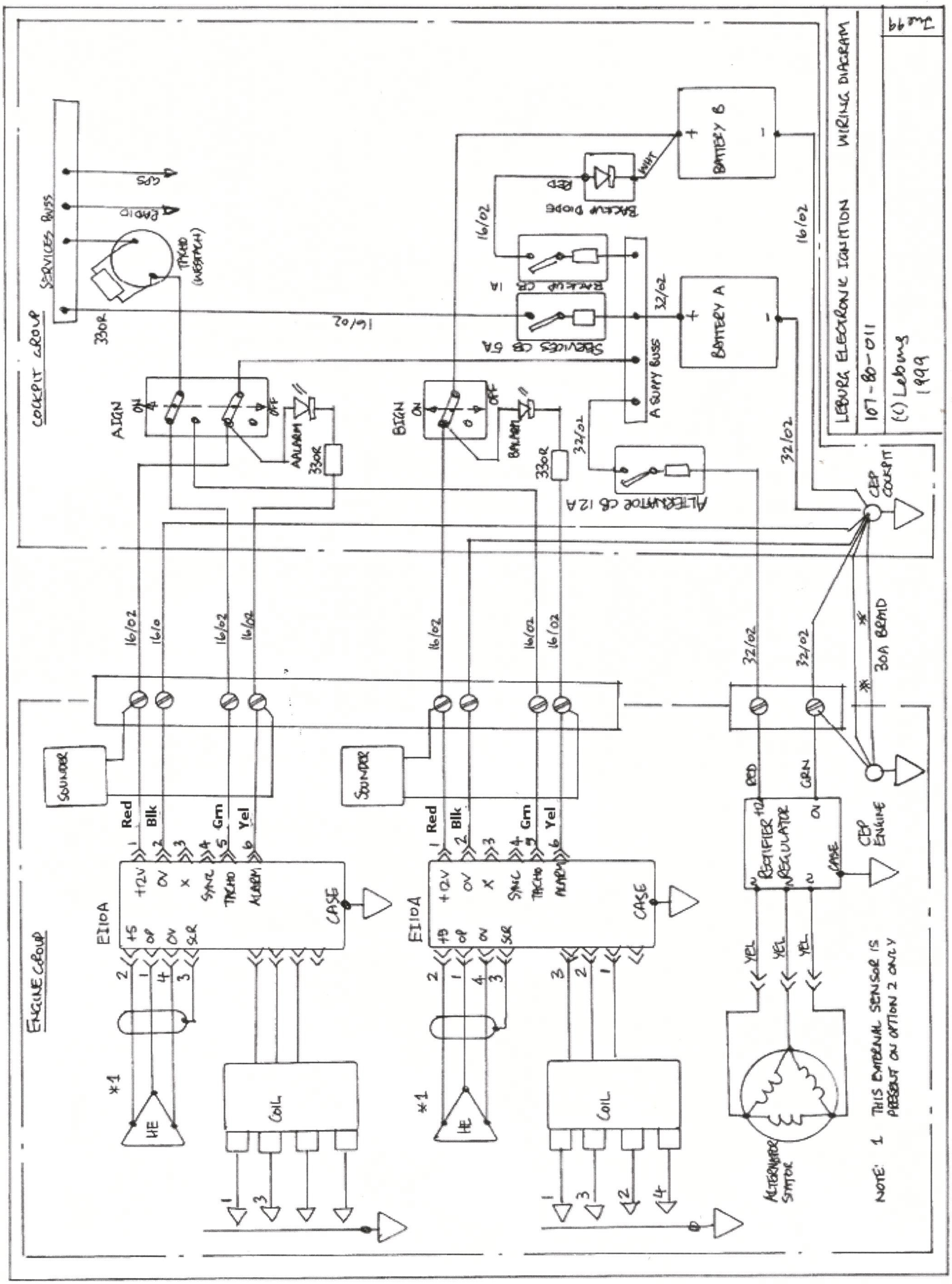


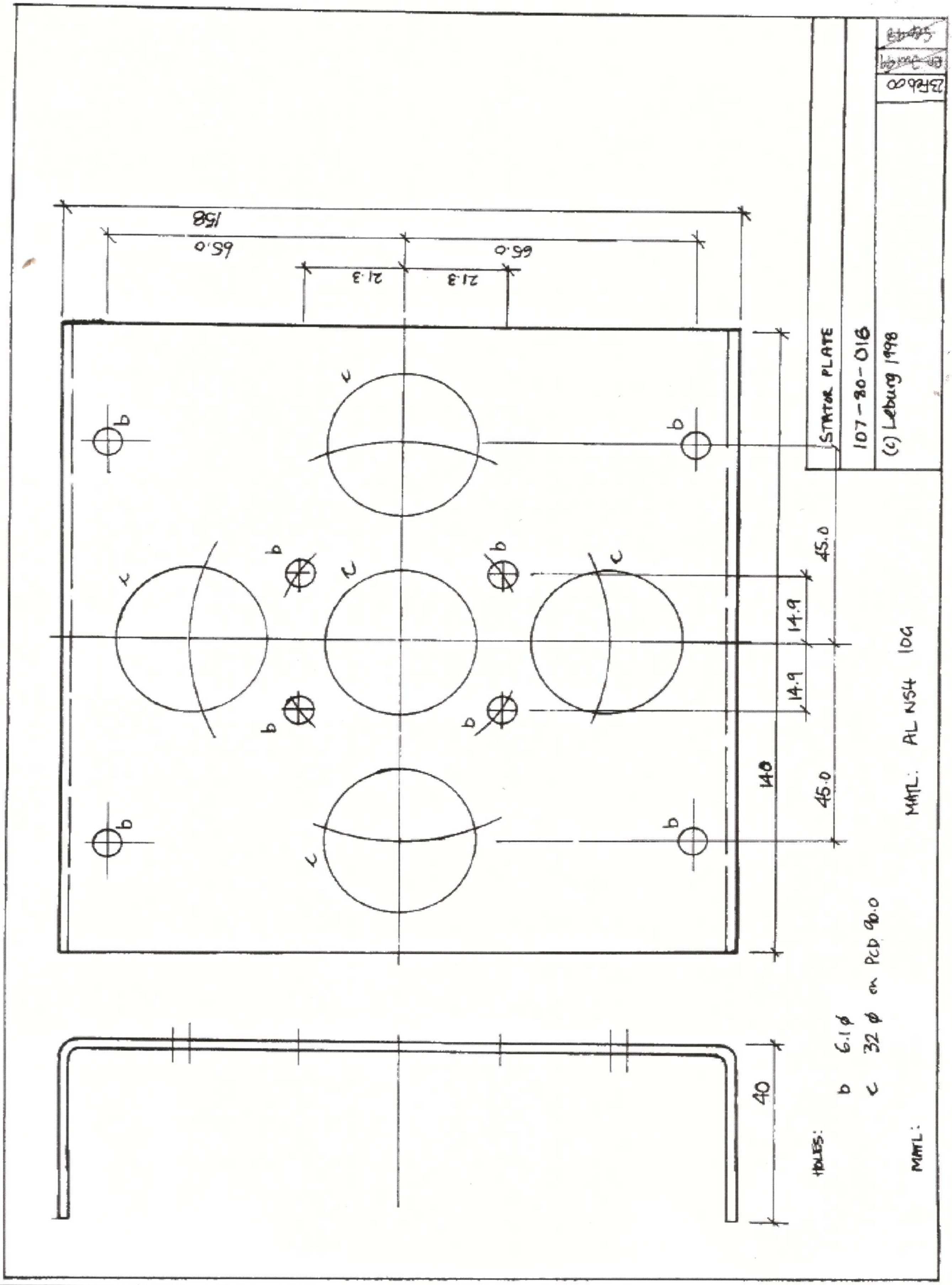
OPTION 2 means using an ignition controller which has an external sensor. This gives the user a wide choice of where to fit the sensor and what sort of alternator to install. You choose this option if you do not wish to, or cannot install OPTION 1.

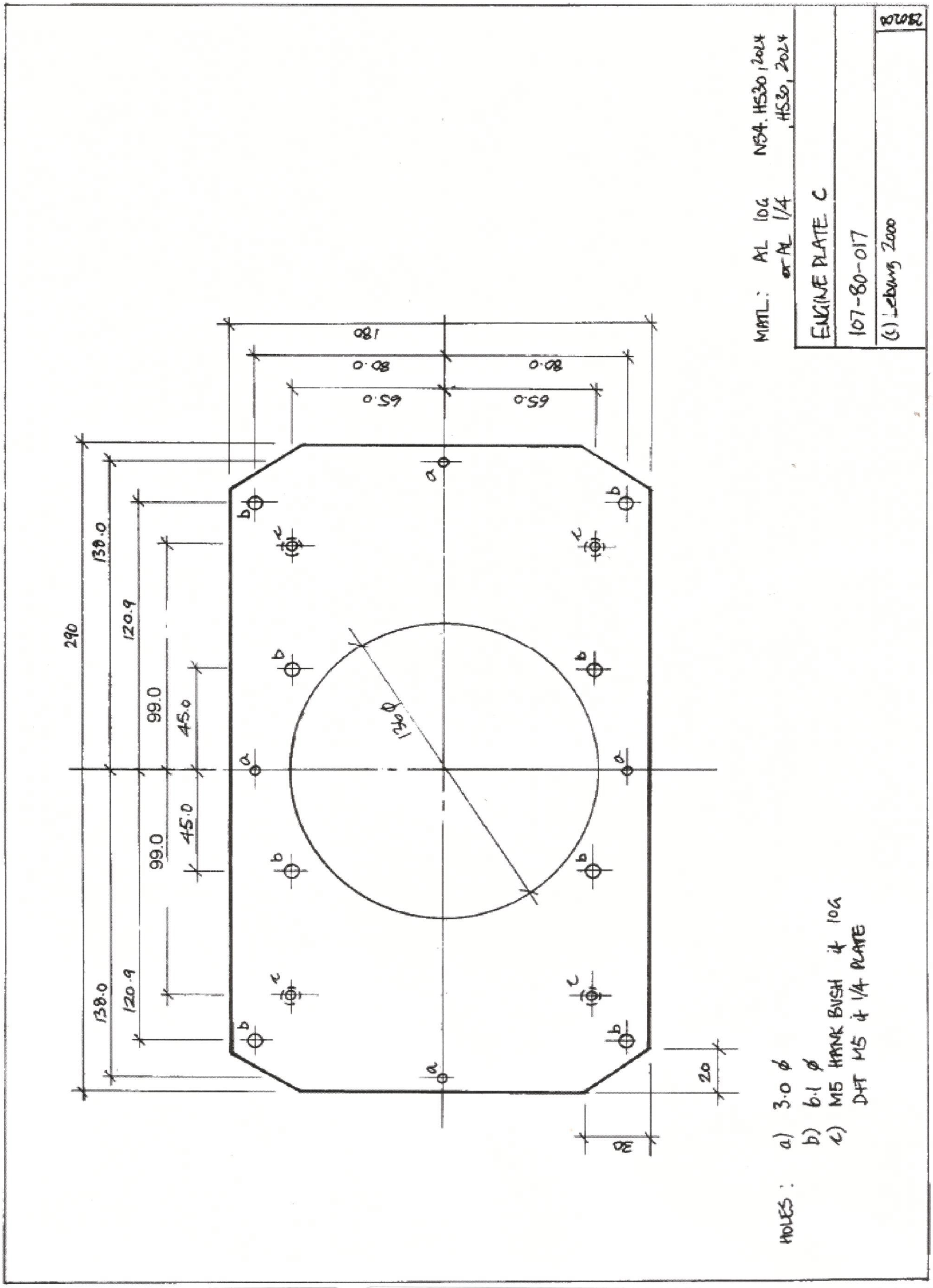
LEBURG IGNITION SYSTEM OPTION 2

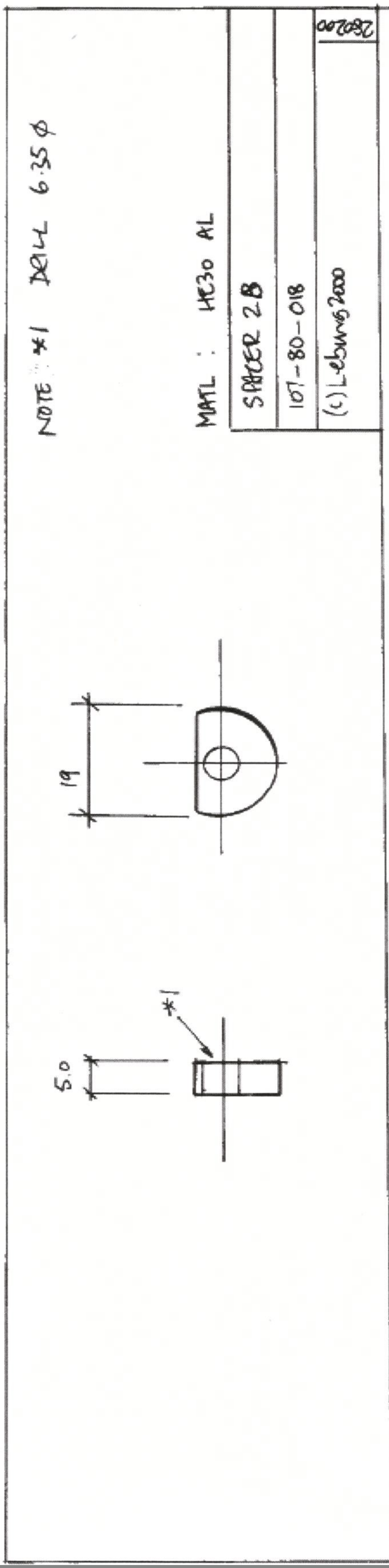
107-80-010

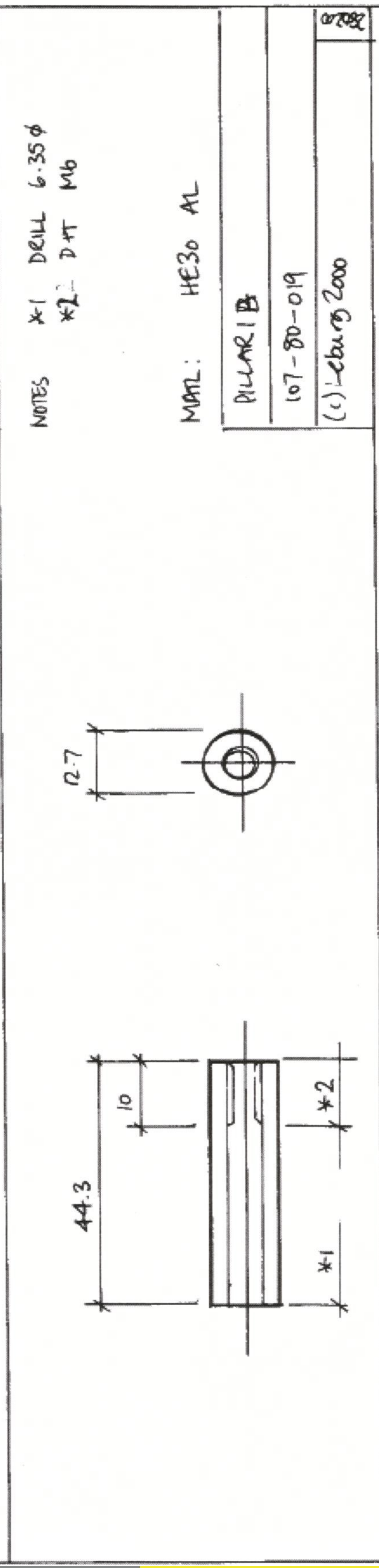
(c) Leburg 1999

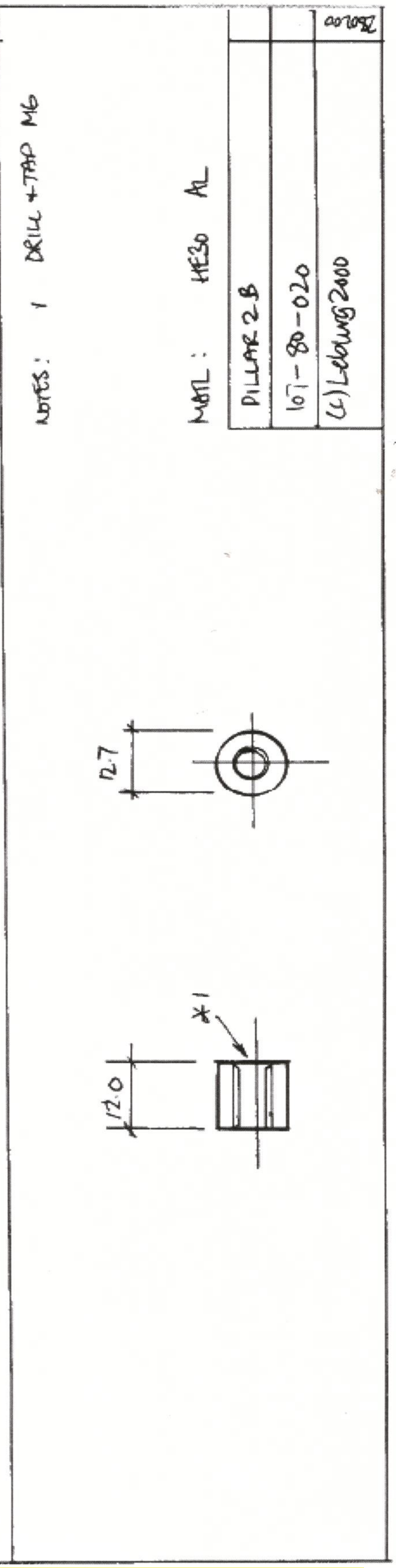

LEBURG ELECTRONIC IGNITION
WIRING DIAGRAM
107-80-011
(C) Leburg 1999
COCKPIT GROUP
ENGINE GROUP
SERVICES BUSS
A SUPPLY BUSS
BATTERY A
BATTERY B
BACKUP DIODE
SERVICES CB 5A
BACKUP CB 1A
ALTERNATOR CB 12A
A IGN
B IGN
A ALARM
B ALARM
SOUNDER
EI10A
COIL
HE
RECTIFIER REGULATOR
ALTERNATOR STATOR
CEP COCKPIT
CEP ENGINE
30A BRAID
NOTE: 1 THIS EXTERNAL SENSOR IS PRESENT ON OPTION 2 ONLY

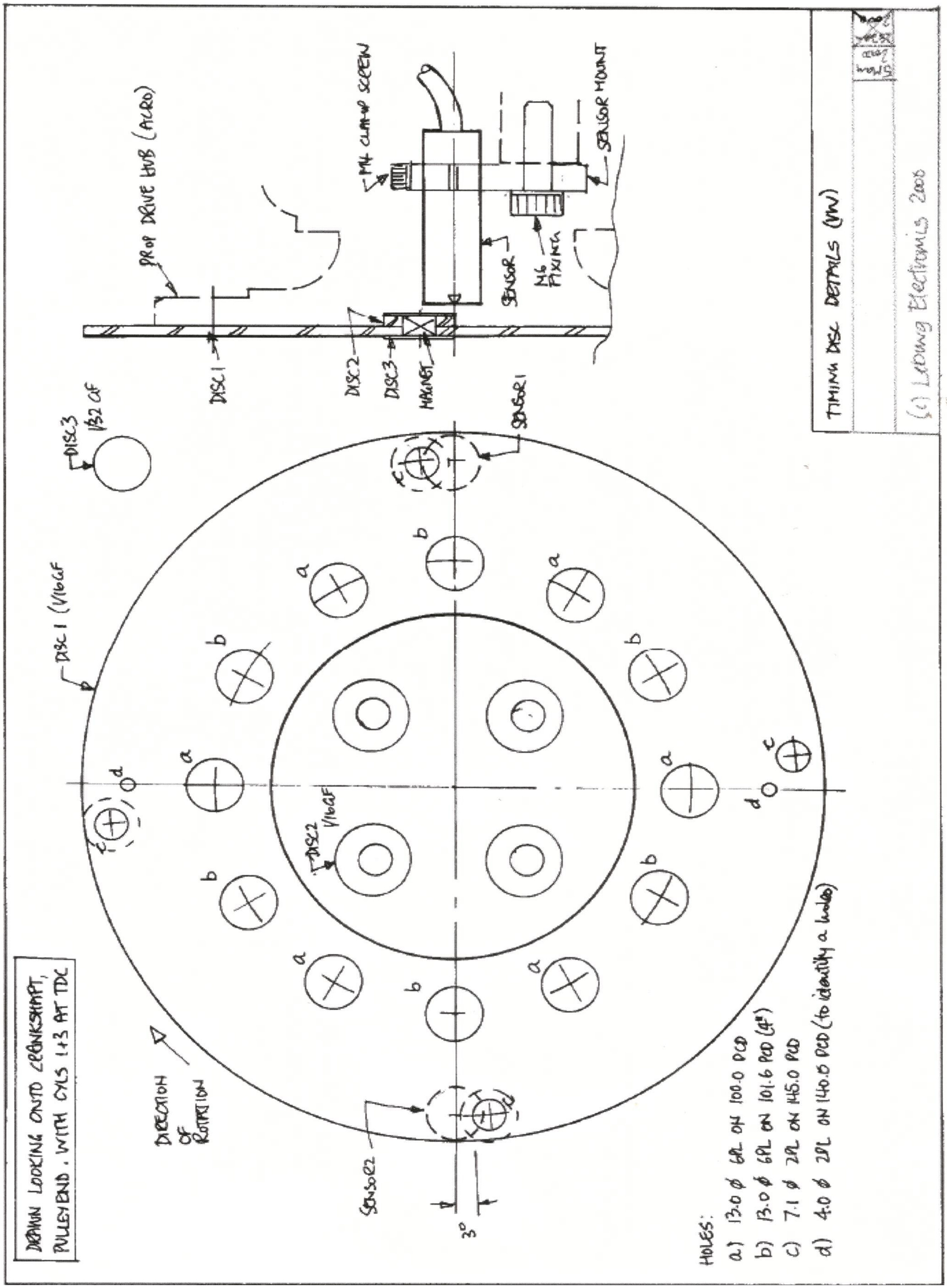

STATOR PLATE
107-80-016
(c) Leburg 1998
23Feb00
158
65.0
65.0
21.3
21.3
45.0
14.9
14.9
45.0
140
40
MATL: AL NS4 10G
HOLES:
b 6.1 ø
c 32 ø on PCD 90.0
MATL:

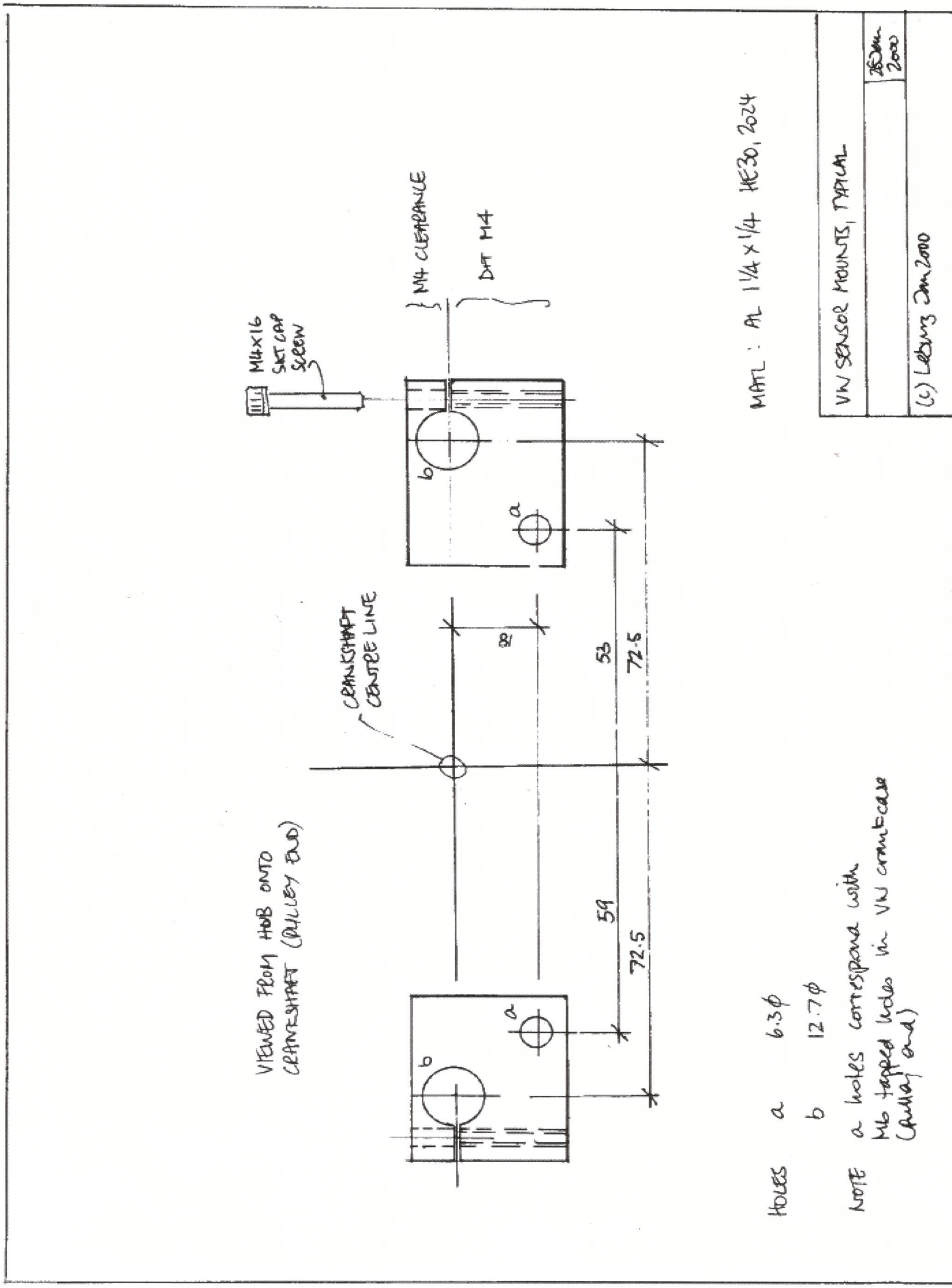

MATL: AL 10G NS4, HS30, 2024
or AL 1/4 HS30, 2024
ENGINE PLATE C
107-80-017
(c) Leburg 2000
180
80.0
80.0
65.0
65.0
290
138.0
120.9
99.0
45.0
45.0
99.0
120.9
138.0
136 ø
20
30
HOLES: a) 3.0 ø
b) 6.1 ø
c) M5 HANK BUSH if 10G
DHT M5 if 1/4 PLATE

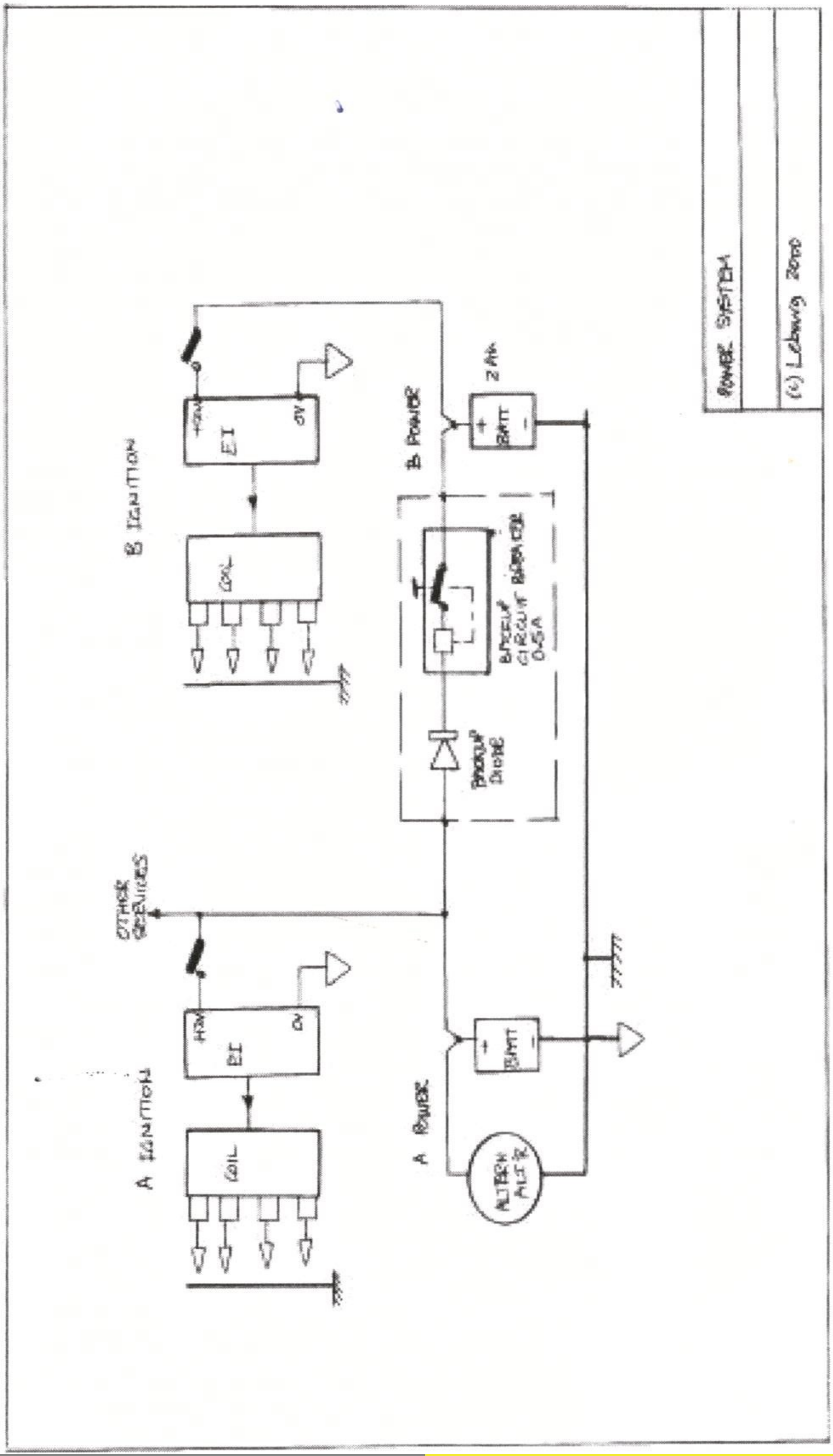

NOTE *1 DRILL 6.35 ϕ
MATL : HE30 AL
SPACER 2B
107-80-018
(c) Leburg 2000
280200
19
5.0
*1


NOTES *1 DRILL 6.35 ϕ
*2 D+T M6
MATL: HE30 AL
PILLAR 1B
107-80-019
(c) Leburg 2000
280200
12.7
10
44.3
*1
*2


NOTES: 1 DRILL + TAP M6
MATL: HE30 AL
PILLAR 2B
107-80-020
(c) Leburg 2000
280200
12.7
12.0
*1


DRAWN LOOKING ONTO CRANKSHAFT, PULLEYEND. WITH CYLS 1+3 AT TDC
DIRECTION OF ROTATION
SENSOR2
3°
HOLES:
a) 13.0 ø 6PL ON 100.0 PCD
b) 13.0 ø 6PL ON 101.6 PCD (4")
c) 7.1 ø 2PL ON 145.0 PCD
d) 4.0 ø 2PL ON 140.0 PCD (to identify a holes)
DISC 1 (V16GF
DISC2 V16GF
DISC3 1/32 GF
SENSOR1
DISC1
DISC2
DISC3
MAGNET
PROP DRIVE HUB (ACRO)
SENSOR
M6 FIXING
M4 CLAMP SCREW
SENSOR MOUNT
TIMING DISC DETAILS (VW)
(c) Leburg Electronics 2008


M4x16 SKT CAP SCREW
M4 CLEARANCE
D&T M4
MAT'L : AL 1¼ x ¼ HE30, 2024
VW SENSOR MOUNTS, TYPICAL
(c) Leburg Jan 2000
26 Jan 2000
CRANKSHAFT CENTRE LINE
32
53
72.5
59
72.5
a
b
VIEWED FROM HUB ONTO CRANKSHAFT (PULLEY END)
HOLES a 6.3 ⌀
b 12.7 ⌀
NOTE a holes correspond with M6 tapped holes in VW crankcase (pulley end)


B IGNITION
COIL
EI
A IGNITION
OTHER SERVICES
B POWER
A POWER
BATT
2 Ah
BACKUP CIRCUIT BREAKER 0.5A
BACKUP DIODE
POWER SYSTEM
(c) Leburg 2000